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# Fort Cobb Reservoir Caddo County, Oklahoma

National Eutrophication Survey, Corvallis, Oreg

Prepared for

Corvallis Environmental Research Lab, Oreg

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16 ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17 KEY WORDS AND DOCUMENT ANALYSIS

| a. DESCRIPTORS | b. IDENTIFIERS/OPEN ENDED TERMS | c. COSATI Field/Group |
|---|---|---|
| eutrophication<br>lakes<br>nutrients<br>phosphorus<br>nitrogen<br>loading | | 05B<br>05C |

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# U.S. ENVIRONMENTAL PROTECTION AGENCY
# NATIONAL EUTROPHICATION SURVEY

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Report

on

FORT COBB RESERVOIR

CADDO COUNTY

OKLAHOMA

EPA REGION VI

Working Paper No. 585

With the cooperation of the

Oklahoma Department of Pollution Control

and the

Oklahoma National Guard

March, 1977

# REPORT ON FORT COBB RESERVOIR

## CADDO COUNTY, OKLAHOMA

## EPA REGION VI

by

National Eutrophication Survey

Water and Land Monitoring Branch
Monitoring Applications Laboratory
Environmental Monitoring & Support Laboratory
Las Vegas, Nevada

and

Eutrophication Survey Branch
Corvallis Environmental Research Laboratory
Corvallis, Oregon

Working Paper No. 585

OFFICE OF RESEARCH AND DEVELOPMENT
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March 1977

1a

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# FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

## OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point source discharge reduction and nonpoint source pollution abatement in lake watersheds.

## ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and imparts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

## LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's freshwater lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by the U.S. Environmental Protection Agency and to augment plans implementation by the states.

ACKNOWLEDGMENTS

The staff of the National Eutrophication Survey (Office of Research and Development, U.S. Environmental Protection Agency) expresses sincere appreciation to the Oklahoma Department of Pollution Control for professional involvement, to the Oklahoma National Guard for conducting the tributary sampling phase of the Survey, and to those Oklahoma wastewater treatment plant operators who provided effluent samples and flow data.

Dr. Denver Talley, Director, Oklahoma Department of Pollution Control; the staff of the Oklahoma Water Resources Board; and the staff of the Oklahoma State Department of Health reviewed the preliminary reports and provided critiques most useful in the preparation of this Working Paper Series.

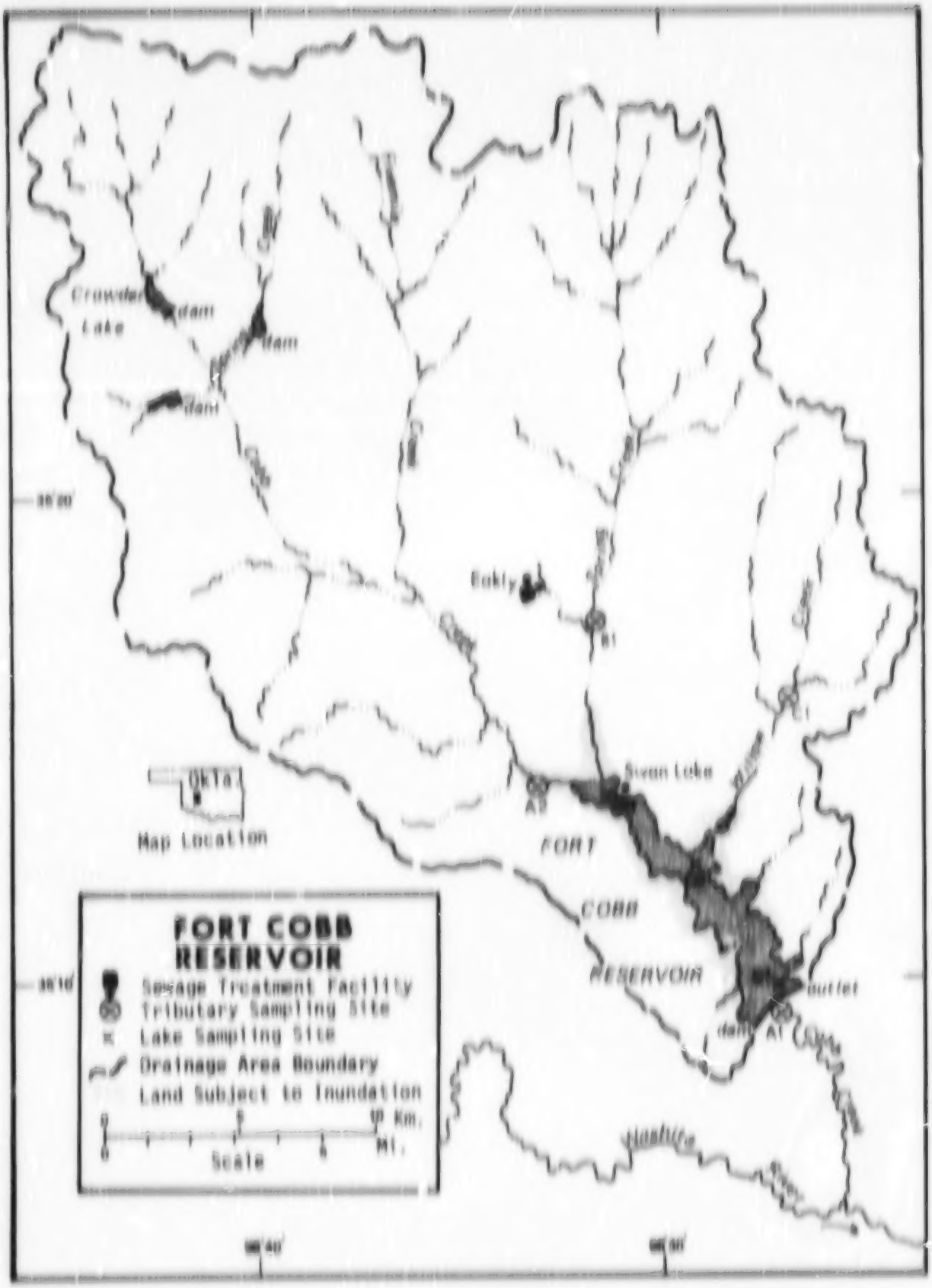
Major General John Coffey, Jr., the Adjutant General of Oklahoma, and Project Officers Colonel Curtis U. Pilligan and Major James O. Haney, Jr., who directed the volunteer efforts of the Oklahoma National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF OKLAHOMA

| LAKE NAME | COUNTY |
|---|---|
| Altus Reservoir | Greer, Kiowa |
| Arbuckle Lake | Murray |
| Lake Elsworth | Caddo, Comanche |
| Lake Eufaula | Haskell, McIntosh, Okmulgee, Pittsburg |
| Fort Cobb Reservoir | Caddo |
| Fort Supply Reservoir | Woodward |
| Foss Dam Reservoir | Custer |
| Lake Frances | Adair |
| Grand Lake O' The Cherokees | Mayes, Delaware, Craig, Ottowa |
| Lake Hefner | Oklahoma |
| Keystone Reservoir | Tulsa, Creek, Osage, Pawnee |
| Oologah Lake | Nowata, Rogers |
| Tenkiller Ferry Reservoir | Cherokee, Sequoyah |
| Lake Thunderbird | Cleveland |
| Wister Reservoir | Leflore |


Crowder Lake
dam
dam
dam
Eakly
Okla.
Map Location
Swan Lake
A2
FORT
COBB
RESERVOIR
outlet
dam
A1
FORT COBB RESERVOIR
Sewage Treatment Facility
Tributary Sampling Site
Lake Sampling Site
Drainage Area Boundary
Land Subject to Inundation
0 5 10 Km.
0 3 6 Mi.
Scale

REPORT ON FORT COBB RESERVOIR, OKLAHOMA

STORET NO. 4005

I. CONCLUSIONS

A. Trophic Condition:*

Survey data indicate that Fort Cobb Reservoir is eutrophic, i.e., nutrient rich and highly productive. Whether such nutrient enrichment is to be considered beneficial or deleterious is determined by its actual or potential impact upon designated beneficial water uses of each lake.

Chlorophyll a values in the lake ranged from 3.3 ug/l in April to 40.9 ug/l in August, with a mean of 15.0 ug/l. High productivity was particularly manifest in the area of the Cobb Creek-Spring Creek inflows (mean chlorophyll a of 29.0 ug/l). Potential for primary production as measured by algal assay control yield was low in the spring sampling period and high during the autumn. Of the 16 Oklahoma lakes sampled in 1974, 11 had higher median total phosphorus levels, 11 had higher median inorganic nitrogen values, and 10 had higher median orthophosphorus levels than Fort Cobb Reservoir.

Survey limnologists reported floating clumps of algae during the spring at Station 01, but no problem aquatic macrophytes.

*See Appendix E.

B. Rate-Limiting Nutrient:

The algal assay results suggest phosphorus limitation in Fort Cobb Reservoir during the spring sampling and nitrogen limitation in the fall. The lake data indicate nitrogen limitation at all sampling times.

C. Nutrient Controllability:

1. Point sources -

Only one known point source, the town of Eakly, was known to impact Fort Cobb Reservoir during the sampling year. This source was estimated to contribute 2.8% of the total phosphorus load to the lake.

The present calculated phosphorus loading of 0.57 g $P/m^2/yr$ is over three times that proposed by Vollenweider (1975) as a "eutrophic" loading. If the present loading continues, increasingly undesirable responses to enrichment are likely to occur.

2. Nonpoint sources -

The phosphorus contributions of nonpoint sources, including precipitation, accounted for 97.2% of the total phosphorus load during the sampling year. Cobb Creek contributed 42.9%, Spring Creek contributed 14.5%, and Willow Creek contributed 6.3%. The ungaged minor tributaries and immediate

drainage contributed an estimated 30.4% of the total phosphorus load.

The nutrient export rates of the gaged tributaries (range of 8-14 kg P/km$^2$/yr, mean of 11 kg P/km$^2$/yr) are slightly higher but comparable to the tributary rates of nearby Elsworth Lake* (range of 3-9 kg P/km$^2$/yr, mean of 6 kg P/km$^2$/yr).

*See Working Paper No. 583, "Report on Elsworth Lake".

## II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

Lake and drainage basin characteristics are itemized below. Lake morphometry was provided by the Oklahoma Water Resources Board. Tributary flow data were provided by the Oklahoma District Office of the U.S. Geological Survey (USGS). Outlet drainage area includes the lake surface area. Mean hydraulic retention time was obtained by dividing the lake volume by mean flow of the outlet. Precipitation values are estimated by methods as outlined in National Eutrophication Survey (NES) Working Paper No. 175. A table of metric/English conversions is included as Appendix A.

A. Lake Morphometry:

1. Surface area: 16.47 $km^2$.
2. Mean depth: 6.4 meters.
3. Maximum depth: 19.2 meters.
4. Volume: 105.408 x $10^6$ $m^3$.
5. Mean hydraulic retention time: 2,773 days (7.6 yrs).

B. Tributary and Outlet:
(See Appendix B for flow data)

1. Tributaries -

| Name | Drainage area($km^2$) | Mean flow ($m^3/sec$) |
|---|---|---|
| A-2 Cobb Creek | 341.9 | 0.57 |
| B-1 Spring Creek (Lake Creek) | 134.7 | 0.21 |
| C-1 Willow Creek | 42.7 | 0.07 |
| Minor tributaries and immediate drainage - | 219.4 | 0.38 |
| Totals | 738.7 | 1.23 |
| 2. Outlet - A-1 Cobb Creek | 767.4 | 0.44 |

C. Precipitation:

1. Year of sampling: 66.0 cm.
2. Mean annual: 72.5 cm.

## III. LAKE WATER QUALITY SUMMARY

Fort Cobb Reservoir was sampled three times during the open-water season of 1974 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from three stations on the lake and from a number of depths at each station (see map, page v). During each visit, depth-integrated samples were collected from each station for chlorophyll a analysis and phytoplankton identification and enumeration. During the first and last visits, 18.9-liter depth-integrated samples were composited for algal assays. Maximum depths sampled were 10.2 meters at Station 01, 6.4 meters at Station 02, and 1.5 meters at Station 03. For a more detailed explanation of NES methods, see NES Working Paper No. 175.

The results obtained are presented in full in Appendix C and are summarized in III-A for waters at the surface and at the maximum depth for each site. Results of the phytoplankton counts and chlorophyll a determinations are included in III-B. Results of the limiting nutrient study are presented in III-C.

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B. Biological Characteristics:

1. Phytoplankton -

| Sampling Date | Dominant Genera | Algal Units per ml |
|---|---|---|
| 09/01/74 | 1. Centric diatom | 2,443 |
| | 2. Chroomonas | 1,000 |
| | 3. Cryptomonas | 193 |
| | 4. Dinobryon | 161 |
| | 5. Ankistrodesmus | 129 |
| | Other genera | 353 |
| | total | 5,079 |
| 06/11/74 | 1. Carteria | 1,130 |
| | 2. Chroomonas | 793 |
| | 3. Cryptomonas | 750 |
| | 4. Stephanodiscus | 552 |
| | 5. Melosira | 344 |
| | Other genera | 1,440 |
| | total | 5,033 |
| 10/24/74 | 1. Chroomonas | 268 |
| | 2. Coscinodiscus | 268 |
| | 3. Oscillatoria | 240 |
| | 4. Anabaena | 112 |
| | 5. Coelosphaerium | 112 |
| | Other genera | 379 |
| | total | 1,385 |

B. Chlorophyll a -

| Sampling Date | Station Number | Chlorophyll a (ug/l) |
|---|---|---|
| 04/01/74 | 01 | 1.3 |
| | 02 | 9.6 |
| | 03 | 22.5 |
| 06/11/74 | 01 | 6.2 |
| | 02 | 9.4 |
| | 03 | 40.9 |
| 10/04/74 | 01 | 9.6 |
| | 02 | 9.7 |
| | 03 | 23.6 |

E. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

| Spike(mg/l) | Ortho P Conc.(mg/l) | Inorganic N Conc.(mg/l) | Maximum Yield (mg/l dry wt.) |
|---|---|---|---|
| a. 04/02/74 | | | |
| Control | 0.005 | 0.066 | 0.1 |
| 0.05 P | 0.055 | 0.066 | 2.9 |
| 0.05 P + 1.0 N | 0.055 | 1.066 | 12.4 |
| 1.00 N | 0.005 | 1.066 | 0.1 |
| b. 10/24/74 | | | |
| Control | 0.017 | 0.107 | 3.2 |
| 0.05 P | 0.067 | 0.107 | 4.0 |
| 0.05 P + 1.0 N | 0.067 | 1.107 | 17.1 |
| 1.00 N | 0.017 | 1.107 | 5.8 |

F. Discussion -

The control yields of the assay alga, Selenastrum capricornutum, indicate that potential for primary production in Fort Cobb Reservoir was low during spring collection and high during autumn sampling. In the spring, the addition of orthophosphorus alone produced a significant increase in yield over that of the control, indicating the sample was phosphorus limited at that time. The addition of only nitrogen resulted in a yield which was not significantly greater than that of the control.

In the autumn assay, the addition of nitrogen alone produced a significant increase in yield over that of the control suggesting primary nitrogen limitation in the sample. The addition of only phosphorus produced a slight increase in yield over that of the control. However, substantial nutrient changes in the samples prior to assay place the findings of both spring and fall assays in question.

The lake data indicate that nitrogen was the primary limiting nutrient during all sampling periods (the mean inorganic nitrogen to orthophosphorus (N/P) ratios were 10/1 or less, and nitrogen limitation would be expected).

## IV. NUTRIENT LOADINGS
(See Appendix D for data)

For the determination of nutrient loadings, the Oklahoma National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff months of April and May when two samples were collected. Sampling was begun in November 1974, and was completed in October 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Oklahoma District Office of the USGS for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a USGS computer program for calculating stream loadings. Nutrient loads indicated for tributaries are those measured minus known point source loads, if any.

Nutrient loadings for unsampled "minor tributaries and immediate drainage" ("ZZ" of USGS) were estimated by using the mean annual nutrient loads, in $kg/km^2$/year, in Cobb Creek and Willow Creek at Stations A-2 and C-1 and multiplying the means by the ZZ area in $km^2$.

Nutrient loads for the Eakly wastewater treatment plant were estimated at 1.134 kg P and 3.401 kg N/capita/year.

A. Waste Sources:

1. Known municipal -

| Name | Pop.* Served | Treatment* | Mean Flow ($m^3/d \times 10^3$) | Receiving Water |
|---|---|---|---|---|
| Ekly | 220 | Stabilization pond | 0.006** | Spring Creek |

2. Known industrial - None

*H. S. Peavy, personal communication. Population 1970 census.
**Estimated at 0.3785 $m^3$/capita/day.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

| Source | kg P/yr | % of total |
|---|---|---|
| a. Tributaries (nonpoint load) - | | |
| A-2 Cobb Creek | 4,015 | 42.9 |
| B-1 Spring Creek (Lake Creek) | 1,355 | 14.5 |
| C-1 Willow Creek | 595 | 6.3 |
| b. Minor tributaries and immediate drainage (nonpoint load) - | 2,850 | 30.4 |
| c. Known municipal STP's - | | |
| Eakly | 260 | 2.8 |
| d. Septic tanks* - | <5 | <0.1 |
| e. Known industrial - None | | |
| f. Direct precipitation** - | 290 | 3.1 |
| Totals | 9,365 | 100.0 |
| 2. Outputs - A-1 Cobb Creek | 590 | |
| 3. Net annual P accumulation | 8,775 | |

*Estimate based on 11 lakeshore residences.
**Estimated (see NES Working Paper No. 175).

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

| Source | kg N/yr | % of total |
|---|---|---|
| a. Tributaries (nonpoint load) - | | |
| A-2 Cobb Creek | 43,220 | 40.6 |
| B-1 Spring Creek (Lake Creek) | 13,920 | 13.1 |
| C-1 Willow Creek | 4,715 | 4.4 |
| b. Minor tributaries and immediate drainage (nonpoint load) - | 25,890 | 24.4 |
| c. Known municipal STP's - | | |
| Eakly | 775 | 0.7 |
| d. Septic tanks* - | 115 | 0.1 |
| e. Known industrial - None | | |
| f. Direct precipitation** - | 17,780 | 16.7 |
| Totals | 106,415 | 100.0 |
| 2. Outputs - A-1 Cobb Creek | 16,100 | |
| 3. Net annual N accumulation | 90,315 | |

*Estimated based on 11 lakeshore residences.
**Estimated (see NES Working Paper No. 175).

D. Mean Annual Nonpoint Nutrient Export by Subdrainage Area:

| Tributary | kg P/km²/yr | kg N/km²/yr |
|---|---|---|
| Cobb Creek | 12 | 126 |
| Spring Creek | 5 | 60 |
| Willow Creek | 14 | 110 |

E. Yearly Loadings:

In the following table, the existing phosphorus annual loading is compared to the relationship proposed by Vollenweider (1975). Essentially, his "eutrophic" loading is that at which the receiving waters would become eutrophic or remain eutrophic; his "oligotrophic" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A "mesotrophic" loading would be considered one between "eutrophic" and "oligotrophic".

Note that Vollenweider's model may not be applicable to water bodies with very short retention times or in which light penetration is severely restricted from high concentrations of suspended solids in the surface waters.

| | Total Yearly Phosphorus Loading ($g/m^2/yr$) |
|---|---|
| Estimated loading for Fort Cobb Reservoir | 0.57 |
| Vollenweider's "eutrophic" loading | 0.18 |
| Vollenweider's "oligotrophic" loading | 0.09 |

## V. LITERATURE REVIEWED

Peavy, Howard S. 1974. Personal Communication. Oklahoma Department of Pollution Control, Oklahoma City, Oklahoma.

U.S. Environmental Protection Agency. 1975. National Eutrophication Survey Methods 1973-1976. Working Paper No. 175. National Environmental Research Center, Las Vegas, Nevada, and Pacific Northwest Environmental Research Laboratory, Corvallis, Oregon.

Vollenweider, R. A. 1975. Input-Output Models With Special Reference to the Phosphorus Loading Concept in Limnology. Schweiz. Z. Hydrol. 37:53-84.

# VI. APPENDICES

## APPENDIX A
## CONVERSION FACTORS

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## CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x $8.107 \times 10^{-4}$ = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.31 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

# APPENDIX B
# TRIBUTARY FLOW DATA

[illegible]

LAKE CASE [illegible]  PLOT CODE [illegible]

TOTAL [illegible] AREA OF LAKE [illegible]

| SUBBASIN | SUBBASIN AREA(SQ. MI) | JAN | FEB | MAR | APR | MAY | ADJUSTED FLOW(CFS) JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
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| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = [illegible]  TOTAL FLOW IN = [illegible]
SUM OF SUBDRAINAGE AREAS = [illegible]  TOTAL FLOW OUT = [illegible]

[illegible] MONTHLY FLOWS AND ANNUAL FLOWS(CFS)

| SUBBASIN | MONTH | YEAR | MONTH FLOW | DAY | PEAK FLOW | DAY | PEAK FLOW | DAY | PEAK FLOW |
|---|---|---|---|---|---|---|---|---|---|
| [illegible] | 11 | 74 | [illegible] | 7 | [illegible] | | | | |
| | 12 | 74 | [illegible] | 14 | [illegible] | | | | |
| | 1 | 75 | [illegible] | 11 | [illegible] | | | | |
| | 2 | 75 | [illegible] | 16 | [illegible] | | | | |
| | 3 | 75 | [illegible] | 24 | [illegible] | | | | |
| | 4 | 75 | [illegible] | 13 | [illegible] | 25 | [illegible] | | |
| | 5 | 75 | [illegible] | 4 | [illegible] | 17 | [illegible] | | |
| | 6 | 75 | [illegible] | 23 | [illegible] | | | | |
| | 7 | 75 | [illegible] | 25 | [illegible] | | | | |
| | 8 | 75 | [illegible] | 3 | [illegible] | | | | |
| | 9 | 75 | [illegible] | 21 | [illegible] | | | | |
| | 10 | 75 | [illegible] | 14 | [illegible] | | | | |
| [illegible] | 11 | 74 | [illegible] | 7 | [illegible] | | | | |
| | 12 | 74 | [illegible] | 14 | [illegible] | | | | |
| | 1 | 75 | [illegible] | 11 | [illegible] | | | | |
| | 2 | 75 | [illegible] | 16 | [illegible] | | | | |
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| | 6 | 75 | [illegible] | 23 | [illegible] | | | | |
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| | 9 | 75 | [illegible] | 21 | [illegible] | | | | |
| | 10 | 75 | [illegible] | 14 | [illegible] | | | | |

# APPENDIX C
# PHYSICAL AND CHEMICAL DATA

[illegible]

[illegible]

# APPENDIX D

# TRIBUTARY AND WASTEWATER TREATMENT PLANT DATA

[illegible]

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| [illegible] | | | | | | | |
|---|---|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
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| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

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[illegible]

| DATE | TIME | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
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| [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 13 | 50 | [illegible] | | [illegible] | | |
| [illegible] | 14 | 38 | [illegible] | [illegible] | [illegible] | | [illegible] |
| [illegible] | 09 | 37 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 14 | 05 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 14 | 15 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 11 | 15 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 09 | 38 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 15 | 55 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 11 | 09 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 09 | 38 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 09 | 49 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 14 | 47 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 10 | 55 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 09 | 48 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

[illegible]

[illegible]

| DATE | TIME | DEPTH | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|---|---|---|
| [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | FEET | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 13 | 15 | 7.210 | 2.700 | 0.140 | 0.130 | |
| [illegible] | 14 | 19 | 0.190 | 1.220 | 0.070 | 0.050 | 0.120 |
| [illegible] | 09 | 15 | 0.190 | 0.560 | 0.040 | 0.020 | 0.060 |
| [illegible] | 13 | 37 | 2.450 | 0.780 | 0.170 | 0.010 | 0.020 |
| [illegible] | 14 | 37 | 0.240 | 0.160 | 0.030 | 0.050 | 0.070 |
| [illegible] | 11 | 13 | 0.280 | 0.400 | 0.060 | 0.040 | 0.090 |
| [illegible] | 10 | 49 | 0.460 | 0.760 | 0.030 | 0.040 | 0.060 |
| [illegible] | 14 | 09 | 0.330 | 0.450 | 0.060 | 0.020 | 0.060 |
| [illegible] | 10 | 30 | 0.290 | 0.450 | 0.060 | 0.030 | 0.060 |
| [illegible] | 14 | 45 | 0.310 | 0.380 | 0.060 | 0.020 | 0.060 |
| [illegible] | 09 | 06 | 0.630 | 0.300 | 0.060 | 0.030 | 0.060 |
| [illegible] | 14 | 30 | 0.110 | 0.300 | 0.020 | 0.020 | 0.040 |
| [illegible] | 10 | 30 | 0.300 | 0.250 | 0.030 | 0.040 | 0.060 |
| [illegible] | 14 | 15 | 0.260 | 0.400 | 0.050 | 0.060 | 0.070 |

# APPENDIX E

## PARAMETRIC RANKINGS OF LAKES SAMPLED BY NES IN 1974

## STATE OF OKLAHOMA

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